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ABSTRACT

Reading is fundamental to learning. Vital to learning is memory, which is the mental faculty used to retrieve what was read and understood. The human brain is about the size of a grapefruit and weighs about as much as a head of cabbage. The cerebral cortex is a kind of problem-solving and memorizing device. The hippocampus plays a critically important role in placing new memories in storage. Neurons transmit electrical signals along their length and synapses are the basis of memory storage. Memory consists of a number of interconnected systems, working together to perform different functions. The process of memory can be broken into recognition, image or information storage, and recall. When the qualities of both brain hemispheres are integrated and used collectively, learning and comprehension are enhanced. Much thinking and remembering is based on a fairly simple associative process. Short-term memory span is limited to the number of chunks of verbal information that it can hold. Images are traditionally divided into imagination images and memory images. There are four general categories for mnemonics: new words, creative sentences, rhymes and songs, and special systems. A "peg" system is a way to help memorize and retain information from a list that must be learned in a specific sequence. Educators would be wise to use kinesthetic tactile memory (muscle memory) more effectively in their teaching, as it far surpasses auditory or visual learning for long-term recall. The human brain has amazing powers and students and educators must not waste this invaluable resource. (Twenty-seven references are attached.) (RS)

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THE AMAZING BRAIN:

Here is an interesting way to help you visualize the brain. The brain is about the size of a grapefruit and weighs about as much as a head of cabbage. It contains more than one hundred billion neurons and the number of possible interconnections between these one hundred billion nerve cells is greater than the number of atoms in the universe. (Ornstein and Thompson 1984).

For a more physical representation, try this. Form each of your hands into a fist. Now, bring your fingers together in such a manner that the heels of your wrists are touching each other. This gives you the approximate size and shape of the entire brain as well as its symmetrical structure. Next, imagine you have a pair of thick, light gray "crinkled" gloves on your hands. By placing your hands on the top of your head, with your little fingers and elbows touching, you will have an idea of the location of the cortex. Finally, place the fingers of each of your hands on the corresponding sides of your head beneath the ear lobes. The brainstem is located in the center of the space between your fingers and hands.

THE CORTEX:

The largest part of the human brain is the cerebrum. It is divided into two halves called hemispheres. The hemispheres are connected by a band of some three hundred million nerve cell fibers called the corpus callosum. The surface of the cerebrum is called the cortex. It is made of more neurons than any other brain structure and is only about one-eighth inch thick. (Ornstein and Thompson 1984).

The cerebral cortex is a kind of problem-solving and memorizing device (Restak 1984). It furnishes us with our most significant human characteristics, including language, thinking and reasoning.

The cortex is the "executive branch" of the brain and is responsible for making decisions and judgements on all the information it receives from the body and the outside world (Restak 1984). "In the cortex decisions are made; the world is organized; our individual experiences are stored in memory; speech is produced and understood; paintings are seen and music is heard (Ornstein and Thompson 1984)."

THE HIPPOCAMPUS:

The hippocampus is named after its curving shape and is one of the most ancient parts of the brain. The hippocampus is a part of the limbic system and is associated with our emotions. It is directly linked with fibers conveying the multisensory inputs of touch, vision, sound and smell.

The hippocampus plays a critically important role in placing

new memories in storage. In addition, the hippocampus and other regions of the limbic system seem to be particularly crucial for putting the memory of visual objects into storage in the cerebral cortex (Ornstein and Thompson 1984).

NEURONS AND SYNAPSES:

The following explanation related to neurons and synapses is taken from the book titled Brain Power. (Beaumont 1989)

> "The human brain contains billions of cells called neurons that transmit electrical signals along their own length. A typical neuron acts like a kind of control unit, sending and receiving messages within the brain. Neurons form complex networks and each one communicates with many others across small specialized gaps, called synapses. A typical neuron may have between one thousand and ten thousand synapses, receiving information from up to a thousand other neurons."
>
> "When a signal reaches a synapses it causes the release of a chemical known as a neurotransmitter. There are many different neurotransmitters in the brain. When released, they excite or inhibit the neurons on the receiving side."
>
> "Synapses are not stable. They change! Such changes are the basis for memory storage because they alter the 'wiring plan' of the brain and so control what kind of information it can process (Beaumont 1989, p.90)."

MEMORY:

As a human being, memory is one of our most remarkable capacities! Memory is the mental faculty of retaining and recalling past experience. The definition of the verb, remember, means to retain in memory, not forget, recall to mind, or to recollect. Both of these definitions, noun and verb, demonstrate that memory is an active process.

"The true art of memory," said Samuel Johnson, "is the art of attention." We remember what we concentrate on (Begley 1986, p.54).

Memory is not a single system (Kail 1976). Instead, memory consists of a number of interconnected systems, working together to perform different functions (Beaumont 1989).

The major purpose of memory is to process information. This task is becoming more and more awesome and complex. There is no question that the volume of knowledge is increasing at a tremendous rate each year. Estimates suggest that the amount of information that is available to us is doubling every twenty months.

The key to keeping pace is to more effectively use the memory capacity inherently contained within our amazing brain. The brain does not lose what has been put into storage. Therefore, what we call "forgetting" is more accurately a reflection of (1) failure to store information in the first place or (2) inability to recall information once it is stored.

PROCESS OF MEMORY:

The process of memory can be broken into three main stages. (1) First, there is recognition, (2) second, the image or information is stored and (3) third, recalling takes place. In other words, three aspects of memory are acquisition, rehearsal and retrieval.

Acquisition is highly dependent on exposure and experience and is closely related to selective attention. (Levine 1987). We are constantly being bombarded with all kinds of stimuli. Some we ignore. Some we hang onto.

Rehearsal is another essential component of memory. Two aspects of rehearsal are maintenance and elaboration. In maintenance, the student repeats the information over and over. In elaborative rehearsal, the student creates rich associations, and/or adds additional ideas to the information (Craik and Watkins 1973).

LEARNING AND REMEMBERING:

Learning is one thing, but remembering or retrieving what you have learned can be something entirely different. It may seem unfair, but if you can't recall facts or concepts in testing or performance situations, the practical results are the same as if you had never studied or learned in the first place.

Storage and retrieval strategies complement each other. Thus, the stronger the memory imprint, the greater the probability of accurate recall at a later time.

IMPROVING MEMORY:

An essential aspect of learning is wanting to know. Why are you studying? Why have you signed up for a particular class? At best you probably will get an "It's required!!" answer. Even if this is true, challenge the students to determine the purpose for spending all these hours in and out of class. Determine your benefits. Make your required time count!! Remember, this is your education. So, evaluate your attitude and purpose.

"There are two key elements in learning to improve your memory. The first involves mastering the techniques that enhance memory. The second involves practice and experience in using these techniques to achieve maximum effectiveness." (Beaumont 1989, p. 108)

HEMISPHERIC FUNCTIONS:

The left hemisphere is more involved and proficient in language and logic than the right. The right, conversely, is more involved and proficient in spatial abilities and "gestalt" thinking.

Current research on the brain shows that the left hemisphere is convergent in nature. Its functioning is linear, logical and rational. It deals with numbers and words, sorting and retrieving information to arrive at the correct or best answer. On the other hand, the right hemisphere deals with images and relationships, seeks patterns and combines information in new and unique ways. It is more divergent in nature (Wonder and Donovan 1984). When the

qualities of both hemispheres are integrated and used collectively, learning and comprehension is enhanced.

SEMANTIC AND EPISODIC MEMORY:

According to Tulving (1972), semantic memory "is a mental thesaurus; organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts and relations (Tulving 1972, p. 386)." In other words, semantic memory is a memory for the storing of information about words and concepts represented in the language and other symbolic systems (Nelson and Brown in Ornstein 1978).

Episodic memory is a form of memory input leading both to remembered autobiographical events and the formation of generalized event structures or scripts representing similar repetitive experiences or routines (Nelson and Brown in Ornstein 1978).

ASSOCIATION:

Much of our thinking and remembering is based on a fairly simple associative process (Brown 1977).

"Our mind is," as William James so sagely observed, "essentially an associating machine (Carnegie 1956, p. 67)." During the process of remembering by association, a connection is created between a new piece of information and information that is already in memory (Brown 1977).

According to Carnegie, "an educated memory depends upon an

organized system of associations...The 'secret of a good memory' is thus the secret of forming diverse and multiple associations with every fact we care to retain (Carnegie 1956, p. 68)." Therefore, if you really want to remember a particular item, it is important that you make a mental connection and that your associations are strong and definitive.

The more that is already known about a subject, the easier it will be to add new information to the memory store. This is one of the reasons that prior knowledge is so essential. It provides the glue to which other learnings can stick.

Interest is likewise a factor. Sometimes, however, it is difficult to separate interest from prior knowledge. This seems logical since the more interest one has in a specific subject, the more time, attention and experience that is likely given to that particular subject. Furthermore, interest and knowledge increase motivation and the cycle repeats!

To help picture the importance of associations and connections, imagine a cobweb. Visualize the numerous and intricate connections which form the structure of a cobweb. Now, picture a pile of cobwebs, one on the other, with all strands being connected both vertically and horizontally. This sort of networking, provides an illustration of the power that is available when there are many associations available for attaching new information. If one connection is weak or "breaks down," there will be other related connections to support the fact.

The memory connections continue to expand and become more intricately interlinked every day. This process assures that a fuller, richer, more well-rounded mental perspective and memory will be acquired (Brown 1977).

CHUNKING:

Miller (1956), in a landmark paper titled "The Magical Number Seven: Plus or Minus Two," introduced the idea that the short-term memory span was limited in the number of chunks of verbal information that it could hold. Thus, the short-term memory functions best when working with no more than five to nine chunks of information. This seems logical because it fits in with the fact that one is unlikely to be able to sub-vocalize more than seven items in less than 10 seconds, which is the approximate time span of the short-term memory store.

It is important to note, however, that the capacity of the short-term memory can be increased by varying the size, or amount, of information "packaged" within each chunk. It appears that the ability to chunk information increases with age (Dempster 1978) and the degree of chunking that is possible depends on the amount of previous knowledge related to the stated subject that is already in store. (Chi 1978.)

IMAGERY AND VISUALIZATION:

Images are traditionally divided into two general classes. One class is termed imagination images and the other is called memory images.

The ability to see an imaginary picture in the mind's eye is sometimes referred to in the literature as "visualization" and sometimes "imaging." The basic distinction lies in the fact that visualization implies movement, whereas imaging can be a still picture (Sterbutzel 1990). For the purposes of this discussion, imaging and visualization will be used interchangeably.

Effective comprehension requires the ability to translate written symbols into meaningful images. The power of imagery has long been illustrated by the saying "a picture is worth a thousand words." Likewise, one may recall the often heard statement, "I can't remember names, but I never forget a face."

When mental images are formed during reading, recall is increased. Visual information is associated with the right part of the brain and verbal information is generally processed in the left hemisphere. When you create a picture to go with a concept or fact, you increase your chances for comprehension and retention as you anchor this information in both hemispheres (Ellis 1985).

When the element of the ridiculous is used in visualizations, memory is enhanced. I think that the brain likes to laugh! The ridiculous often stimulates humor and is a change of routine. Thus, when you use humor you are keying in on concentration, attention and emotion.

LINKING AND STORY MEMORY:

Information that is visualized can be easily linked. If this linking creates a story that follows the story structure, memory is

enhanced. Stories are a part of one's life from early in development. Since the story structure is familiar, it seems to be easy to connect pieces of information together to assist in memory and retrieval. Linking is like the domino effect: one memory triggers another and then another and then another until all learnings are retrieved.

MNEMONICS:

Techniques for improving memory date back more than 2000 years to the Ancient Greeks. Mnemonics are used chiefly to assist in rote memorization of lists or items in a fixed order. Mnemonics lead to a substantial improvement in memory performance for specific tasks.

There are four general categories for mnemonics: 1. new words 2. creative sentences 3. rhymes and songs and 4. special systems, including the loci system and the peg system. (Ellis 1985)

1. NEW WORDS

Acronyms are words, real or created, developed by using the first letter or letters of a series of words. Acronyms make extensive use of the associative principle.

A. MUSIC: If you took piano lessons, you probably remember your teacher helping you learn the treble clef names of the space notes by associating the word FACE.

b. GEOGRAPHY: By using the word HOMES, you have an excellent acronym for remembering the Great Lakes: Huron, Ontario, Michigan, Erie and Superior.

C. PHYSICAL SCIENCE: Thousands of students have remembered the colors of the rainbow by memorizing the mnemonic acronym, ROY G. BIV. The colors of the visible spectrum are red, orange, yellow, green, blue, indigo and violet.

D. VOCABULARY: Many words are acronyms. For example, NASA stands for National Aeronautics and Space Administration. ZIP CODE stands for Zone Improvement Plan Code. RADAR is created from Radio Detecting and Ranging. SCUBA comes from Self-Contained Underwater Breathing Apparatus. LASER is developed from Light Amplification by Stimulated Emission of Radiation. Most persons are unaware of the many words that are actually acronyms.

2. CREATIVE SENTENCES:

Acrostics are sentences created by constructing words that begin with the first letters of a series of words.

A. MUSIC: For example, the names of the line notes of the treble clef staff (E, G, B, D, F) might be remembered by associating the acrostic EVERY GOOD BOY DOES FINE.

B. PLANETS: The acrostic, MY VERY EARTHLY MOTHER JUST SERVED US NINE PIZZAS, is an excellent way to remember the plants in our Solar System in order of their location from the sun.

C. SPELLING: Many students learn how to spell difficult words by using acrostics. While in elementary school, you may have learned to spell the word GEOGRAPHY by remembering GEORGE EDWARD'S OLD GRANDFATHER RODE A PONY HOME YESTERDAY.

D. MATHEMATICS: To remember the order of the metric system, think of the sentence KIDS HAVE DROPPED DEAD CONVERTING METRICS (kilos, hecto, deka, deci, centi, milli).

3. RHYMES AND SONGS:

Rhymes and songs have been used for centuries to teach children basic facts in education.

A. MONTHS: Perhaps one of the most common mnemonics to remember the number of days in each month is the classic rhyme "THIRTY DAYS HAS SEPTEMBER, APRIL, JUNE, AND NOVEMBER. ALL THE REST HAVE THIRTY-ONE EXCEPT FEBRUARY WHICH HAS TWENTY-EIGHT."

B. ALPHABET: Early childhood is the time to learn the twenty-six letters of the alphabet in sequence. This is much more easily accomplished by learning the ALPHABET SONG. The lyrics are: A B C D E F G/ H I J K L M N O P/ Q R S/ T U V/ W X/ Y and Z. Now I've said my A B C's. Tell me what you think of me.

C. HISTORY: A common rhyme for remembering an important history fact is "In fourteen hundred and ninety-two, Columbus sailed the ocean blue."

D. SPELLING: For words such as relieve and receive, remember the rhyme I BEFORE E EXCEPT AFTER C. To spell the word PIECE correctly, remember the phrase A PIECE OF PIE.

4. SPECIAL SYSTEMS:

PEG SYSTEMS:

LOCI SYSTEMS:

PEG SYSTEM:

A peg system is a way to help memorize and retain information

from a list that must be learned in a specific sequence. A key word is attached to a sequential number which collectively becomes a "permanent peg." In order to make any peg system useful, the student will need to think of interesting associations, make them meaningful and then rehearse them so that they will be locked into long-term memory. Once the "pegs" are in long-term storage, they can be used to associate any list of items that need to be remembered.

Here are ten "pegs" that could be taught to students. These "pegs" use number concepts as a basis for associative linking.

1. won
2. two
3. tree
4. star
5. foot
6. six-pack
7. 7-UP
8. ate
9. 9-iron
10. tent

The following is a brief explanation of some associations that may make the "permanent pegs" meaningful for students. 1. Won is a homonym for one and provides action. 2. Two remains two or is thought of as a tutu. 3. Tree is the word three with the letter h left out. 4. Four is associated with a four star rating. 5. Foot is connected to the song phrase "five foot two, eyes of blue." 6.

Six-pack is related to a six-pack of beverage. 7. 7-UP is a favorite soda. 8. Ate is the homonym for eight. 9. 9-iron is associated with golf. 10. Tent is the word ten with the letter t added at the end to form a concrete item that can easily be visualized.

For example, suppose the history teacher asked the students to know the first ten Presidents of the United States in order. They are as follows: WASHINGTON, ADAMS, JEFFERSON, MADISON, MONROE, JACKSON, VAN BUREN, HARRISON, AND TYLER. This is an excellent opportunity to use a peg system since sequence is important.

Now that the "permanent pegs" can be recalled immediately, study time will be spent in forming associations to connect the peg words to the Presidents--the known to the unknown. Here is an example; however, it is important to remember that there are many ways to form meaningful associations.

1. WASHINGTON won the war.
2. There were two ADAMS.
3. JEFFERSON is climbing a tree.
4. MADISON is a star at Madison Square Gardens.
5. MONROE rows his boat with his feet on Monday.
6. The ADAMS name appears again so they celebrated with a six-pack.
7. JACKSON'S son, Jack, likes 7-UP.
8. VAN BUREN ate eight burritos in his van.
9. HARRISON was playing golf with his 9-iron.
10. TYLER was sleeping in a tent.

If the students still find it difficult to remember the individual associations, encourage them to put several sentences together to form a sentence story or link those together to form a longer story. Be sure to visualize the action of the story and add appropriate emotion to personalize it. Dramatization through visualization is a great memory enhancer that needs no external aids. It only requires the power of the imagination!

MODES OF LEARNING:

We are multisensory learners. Basically, we use auditory, visual and kinesthetic tactile modes to help us remember. I would say that the most often used method of instruction in the classrooms is auditory presentation. Next, I believe is visual. Last, is kinesthetic tactile.

However, most of us can think of illustrations whereby muscle memory far surpassed auditory or visual learning for long term recall. Driving a car, riding a bicycle or playing tennis or golf would be good examples. If you didn't do one of these activities for a period of time do you think you would forget how? Sky writing, table top writing, sand writing and body imprinting are all examples of using our muscles to help in memory. Do you make lists? You are using kinesthetic tactile memory. Our muscles have fantastic memories. We would be wise to use them more effectively in our teaching and learning.

SUMMARY:

Reading is fundamental to learning. Vital to learning is

memory, which is the mental faculty we use to retain and retrieve what we have read and understood. Skills and strategies can be learned which, in turn, will enhance the memory resources already used in reading experiences. It is imperative that we give students every opportunity to successfully compete in a world that demands reading proficiency and access to great stores of knowledge. Our brain has amazing powers and we must not waste this invaluable resource!

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